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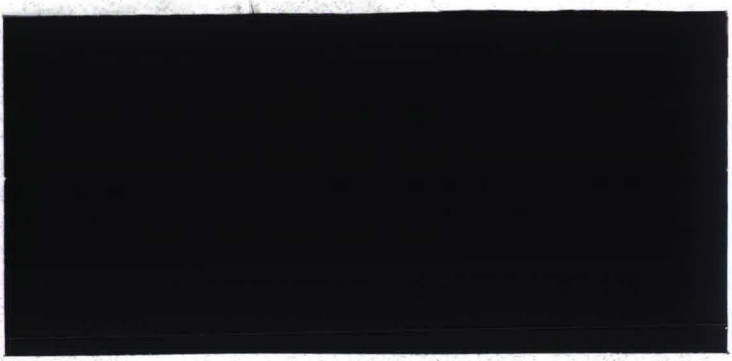

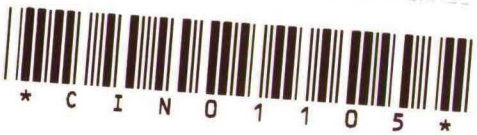

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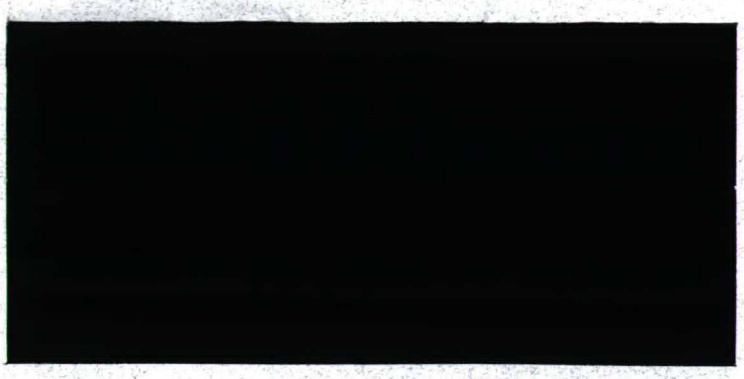

SOCIAL WELFARE EFFECTS OF A COMMON CURRENCY

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Social welfare effects of a common currency.

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Abstract

This paper considers the possible social welfare consequences of replacing a national currency by a common currency, the ECU, managed by an -at least juridically- independent European Central Bank. A final replacement of national currencies imposes upon the national economy a European-wide interest rate/inflation rate, which could affect social welfare considerably if the EC is not an optimal currency area. Welfare gains from a final replacement of national currencies by the ECU result in the form of lower transaction and information costs. If the benefits from a common currency exceed the costs, a replacement of a national currency by a common currency is efficient. If it is efficient a country can be expected to join the common currency area, if not the country will want to maintain its national currency. In the empirical part the structural parameters of the model are estimated for the EC countries to assess whether currently a replacement of their national currency by a common currency is efficient or not.

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[1] Crucial comments from Harry Huizinga have motivated this paper. All errors are necessarily my own. Comments are very welcome

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§ 1. *Introduction*

The Maastricht treaty envisages the replacing in the EC of national currencies by a single European currency, the ECU, issued and managed by a European Central Bank (ECB) from 1997 or 1999 at last onwards. The ECU was introduced in 1979, with the Exchange Rate Mechanism, to serve three main purposes: to provide a zone of monetary stability, to support closer monetary cooperation and to foster economic and monetary unity in Europe. During the transition phase towards a European Monetary Union the ECU is likely to become increasingly important as a parallel currency of national currencies. The 'hard-ECU' proposal made by the UK Treasury in 1990 advocates stimulating ECU currency substitution in Europe as a way to achieve a monetary union. In the past, some countries actively stimulated the use of the ECU, particularly France and Italy. Until 1987, on the other hand, a country like Germany forbade its residents to hold ECU denominated assets.

In its influential study 'One Market, One Money', the European Commission (1990) assessed the potential benefits of the replacement of national currencies by a European currency. Direct benefits result from a reduction in transaction - and information costs that a common currency allows.

Possible costs of a common currency are created if the participating countries do not form an optimal currency area, a point stressed by Canzoneri & Rogers (1990). Whether countries form an optimal currency area depends on the marginal excess burden of ordinary taxation: if the marginal costs of ordinary taxation do not differ widely between the countries involved, the optimal rate of inflation will also lie within a narrow range, making a common currency more likely to be an efficient device, since the social benefits of a common currency in a reduction in transaction costs are then likely to exceed the social costs of a European rate of inflation that differs slightly from a national rate of inflation that would have been optimal.

The ECU is currently constructed as a basket of the EC currencies. The weights of the currencies approximate the weights of the national economies in the EC-total and can be adjusted after negotiations. In foreign exchange markets the market value of the ECU is determined: the market value of the ECU can differ from its official value but not systematically since that would imply riskless arbitrage opportunities. Arbitrage between

the ECU market interest rate and a basket of equivalent financial assets in the national currencies will also ensure that ECU interest rates do not deviate from a 'basket' interest rate, apart from a margin that reflects differences in transaction and information costs. These transaction and information costs are an important 'raison d'être' of ECU assets. Apart from the special way that it is constructed, the ECU satisfies already all characteristics of an ordinary currency.

Financial markets in ECU denominated assets[1] have expanded strongly in the last decade: currently, an amount of ECU 221 bn ECU-denominated assets is traded in international financial markets, making it the third currency in international bond markets. At present a full program of monetary and financial instruments, from current deposits to forward contracts, is offered. The attractiveness of ECU-denominated assets lies in the offered lowcost means of acquiring an EC-wide currency diversification and the stable value of the ECU. The ongoing process of monetary, financial and real integration is likely to have exerted a substantial stimulus to the use and usefulness of ECUs. While the use of ECU denomination has been almost exclusively concentrated in the financial sphere, it is also possible to use ECUs in non-financial transactions[2]. The basket characteristic will change when the ECU has replaced the national currencies: all countries instead will have a share in the ECB.

Aim of this paper is to evaluate the most important consequences of replacing a national currency by a common currency. With the aid of a small EC economy model that is worked out, the resource- , public finance -, and the social welfare consequences of the final replacement of the national currencies by a common are currency are studied.

The structure of this paper is as follows : section 2 introduces the basic small economy macroeconomic model of an EC country that underlies the current analysis. Social welfare with a national currency is determined when authorities set the interest rate

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[1] Allen (1990) gives a good introduction on ECU money - and financial markets.

[2] ECU denomination of inter-EC trade did not exceed 1% at the end of 1989 and is not likely to have increased dramatically since then. The use of ECU sight deposits, time accounts and savings account is not yet general in the EC. ECU notes and coins were only issued on special occasions. Consequently, their collectors value exceeds the face value significantly. The effective monopoly of domestic money as a transactions currency has not been affected by the ECU, untill now. Currently, the EC countries are engaged in removing the remaining legal and other obstacles to the use of the ECU as legal tender.

such as to maximize domestic social welfare. Section 3 considers the consequences of a replacement of a national currency by the ECU, issued and controlled by the ECB. Monetary policies initiated by this institution will have a major influence on social welfare of the participating countries. In section 4 the theoretical model of section 2 and 3 is evaluated empirically in an attempt to shed more light on the social welfare consequences of replacing national currencies by a common currency. Section 5 concludes.

§ 2. *The basic model.*

Consider a small open European economy with a national currency. Money demand is based on the money-in-the-utility function approach and results from the following intertemporal optimization program that the representative domestic agent is solving:

$$\max_{c_t, m_t} U_t = \int_{t_0}^{\infty} \{u(c_t) + v(m_t)\} e^{-\delta t}\, dt \qquad u_c, v_m > 0 \qquad u_{cc}, v_{mm} \leq 0 \tag{1}$$

$$\begin{aligned} s.t. \qquad \dot{w} &= r_t w_t + y_t - \tau_t - c_t - i_t m_t - h \\ w_t &= \frac{W_t}{p_t} = \frac{M_t}{p_t} + \frac{e_t F_t}{p_t} = m_t + f_t \\ \lim_{t \to \infty} f_t e^{-\delta t} &= 0 \qquad m_t \geq 0 \end{aligned} \tag{2}$$

Utility depends on real consumption and the amount of real money balances. All real variables are in logarithms. c_t denotes real consumption of the domestic agent, y_t is real income which is assumed to be given and constant, τ_t are lump-sum taxes that are imposed by the fiscal authorities. m_t are domestic agents' holdings of domestic real money. Risk free bonds denominated in domestic currency and in foreign currency are the only available financial assets. i_t is the nominal interest rate on bonds in domestic currency. Real wealth, w_t, consists of real domestic money and net foreign assets, f_t, which are subject to a no-Ponzi game condition that prevents individuals -and the aggregate of individuals when we aggregate- from a scheme of continuously rolling over an ever increasing amount of net foreign assets - or foreign debt.

It is convenient to express net foreign assets in ECUs: e_t then is the ECU exchange rate of domestic currency at time t, i_t^{ecu} is the nominal ECU interest rate, p_t and p_t^{ec} are the domestic and the weighted EC average price level at time t. The rate of time preference is given by δ. r_t is the real rate of interest. h are information and transaction costs that are incurred every period from the use of national monies in the EC. These costs are introduced here as being independent of other variables of the model and form a deadweight resource loss to the individual and in general to society. The static efficiency gains from a common currency in the next section result from the disappearance of the information - and transaction costs h when national currencies are replaced by a common currency.

Solving the maximization problems of the representative agents yields the following first-order conditions from which the implicit demand functions for consumption goods and domestic money can be derived:

$$u_c = \lambda \qquad (3a)$$
$$v_m = i_t \qquad (3b)$$
$$\dot{\lambda} = \lambda(\delta - r_t) \qquad (3c)$$

in which λ is the co-state variable associated with real consumption. The real economy is assumed to be in equilibrium over time: the real rate of interest is assumed to be equal to the rate of time preference. Real consumption and real money balances, furthermore, enter the utility function in a separable fashion:

$$r_t = \delta \qquad \forall t \qquad u_{cm} = 0 \qquad (4)$$

Given the assumptions in eq. (4) and the Fisher-hypothesis, the inflation rate moves jointly with the nominal interest rate:

$$i_t = \delta + \pi_t \qquad (5)$$

Assume that relative purchasing power parity and uncovered interest rate parity hold throughout the analysis[3]: the expected rate of depreciation of the ECU spot rate is equal to the difference between domestic inflation and the weighted average EC inflation rate -with

[3] See Lemmen and Eijffinger (1994) for EC empirical evidence on these assumptions.

weights that reflect the ECU weights of the EC currencies-, and is also equal to the nominal interest rate differential:

$$\dot{e} = \pi_t - \pi_t^{ec} = i_t - i_t^{ecu} \tag{6}$$

in which $\dot{e}$ is the expected rate of depreciation of the ECU spot rate of the small country, which is equal to the actual rate of depreciation if we assume perfect foresight. Due to the assumptions of PPP, UIP and perfect foresight, equivalence between setting the rate of depreciation as part of active exchange rate management, the rate of interest and the rate of money growth will hold since all three monetary instruments will have the same one-to-one impact on the rate of inflation[4]. In the presence of uncertainty, this equivalence will break down, as shown by Poole (1970).

Public finance in country i is subject to the usual dynamic government budget constraint:

$$g_{it} + \kappa_i(\tau_{it}) - \tau_{it} = s_{it} = i_{it} m_{it}^s \tag{7}$$

in which g_{it} are real government expenditures, $\kappa_i(.)$ are tax collection costs, τ_{it} are real taxes. s_{it} are real seignorage revenues accruing to the monetary authorities because of their monopoly in creating domestic (base) money and their ability to set i_{it}[5]. m_{it}^s is the supply by the monetary authorities of real domestic money. According to eq.(7) ordinary taxes have to be adjusted each period to bridge the difference between real government spending on public goods and tax collection costs and real seinorage revenues.

Tax collection costs $\kappa_i(\tau_{it})$ are assumed to be increasing and convex in τ_{it}:

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[4] Note that constant real interest and real exchange rates do not give an accurate description of macro-economic reality in the short-run. Varying real interest and exchange rates are considered as important adjustment devices in the real economy in the short-run. Since our analysis comes down to a steady-state comparison of social welfare in different monetary policy regimes, our simplifications may not be that inappropriate.

[5] Real seignorage revenues in eq.(7) are defined according to the 'opportunity cost' definition. The 'cash-flow' approach distinguishes two result from two distinct sources : a) passive seignorage which results from growth of real money balances, $\dot{m}_i^s$, and b) active seignorage, $\pi_{it} m_{it}^s$, which results from the inflation tax on money. These two sources are referred to as passive and active, respectively, since only with respect to the latter monetary plicymakers are assumed to develop active policies.

$\kappa_i'(\tau_{it}) > 0$ and $\kappa_i''(\tau_{it}) \geq 0$ with $\kappa_i(0) = 0$. $\kappa_i''(\tau_{it}) = 0$ implies that the marginal collection costs are constant, whereas $\kappa_i''(\tau_{it}) > 0$ implies that marginal tax collection costs increase with a higher level of taxation. Vègh (1989) shows that optimal interest rates are a constant viz. an increasing function of government spending when marginal tax collection costs are a constant viz. an increasing function of ordinary taxes. The tax collection costs in our model summarize the social costs of ordinary taxation. Regarding the tax collection costs $\kappa_i(\tau_{it})$, we simply assume that they are linear in taxes, τ_{it}:

$$\kappa_i(\tau_{it}) = \beta_i \tau_{it} \tag{8}$$

β_i is equal to the marginal distortion of ordinary taxes, $\kappa_i'(\tau_{it})$, and measures the relative efficiency of the tax system: countries with high β_i's are relatively inefficient in raising taxes and consequently raising taxes in such a country is relatively costly from a welfare perspective. Linearity of tax collection costs in eq.(8), implies that marginal tax collection costs are constant: while this assumption is restrictive to some extent, it allows to reduce computational complexity considerably. The tax collections are important in the remainder of the analysis since they are the reason why EC-countries are likely to have different optimal inflation rates: in EC-countries with high marginal tax collection costs, a higher rate of inflation is optimal than in EC countries where those costs are relatively low. When EC-countries do not vary much in the relative marginal costs of operating a tax system, the countries constitute an optimal currency area. Canzoneri & Rogers (1990) cast the optimal currency aspect of a common currency into a formal model.

The inflation tax, as ordinary taxes, is distortionary since a higher rate of domestic inflation induces agents to hold fewer domestic balances, according to eq.(3b): only when the domestic nominal interest rate is equal to zero, households' demand for domestic money will be satiated. Without any tax collection costs or other social costs from ordinary taxation the optimal inflation rate would equal the Friedman rule which prescribes a zero nominal interest rate. If ordinary taxes are distortionary -or with increasing collection costs- the Friedman rule is not optimal: efficient taxation requires setting

positive nominal interest rates[6].

Given our representative agent assumption, aggregation over all individuals of country results in macroeconomic demand for consumption goods and real money balances in country i. Consider the following utility function in eq.(1):

$$U_{it} = \int_{t_0}^{\infty} \{c_{it} - \frac{\theta_i(\gamma_i - m_{it})^2}{2}\} e^{-\delta t} dt \qquad \gamma_i, \theta_i \geq 0 \tag{9}$$

in which γ_i reflects the optimal amount of real money. The other utility parameter θ_i weighs the squared deviations of actual money balances from this hypothetical optimum amount.

Optimal real balances of domestic money result when the marginal utility of holding real money balances, is equal to the domestic nominal interest rate. This first-order-condition can be solved to give m_{it} as a function of the domestic interest rate i_{it}:

$$m_{it} = \gamma_i - \frac{1}{\theta_i} i_{it} \tag{10}$$

A 1% rise in the domestic interest rate induces a decrease in the demand for domestic money by $1/\theta_i$%. $-1/\theta_i$ is equal to the ordinary interest rate semi-elasticity of real money demand. To ensure positive real money balances, it is assumed that the following inequality is not violated:

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[6] Efficient taxation entails the minimization of the discounted social costs of financing an amount of public expenditures. Efficient taxation requires (a) the equalization of the marginal excess burden of all forms of taxation in one period (a static optimality condition), (b) the equalization of marginal costs of ordinary taxation over different periods, a principle that is known as Barro's tax smoothing hypothesis, and (c) the equalization over time of marginal social costs of inflation taxation. (b) and (c) are dynamic optimality conditions. Empirical testing of the implications of optimal taxation principles would amount to testing whether inflation and ordinary tax rates are cointegrated (static optimality condition) and whether inflation and ordinary tax rates are random walks (dynamic optimality conditions). The presence of cointegration indicates that inflation - and ordinary tax rates are set efficiently *intra*temporally, while evidence of random walks in inflation - and ordinary tax rates, presents evidence for tax-smoothing, i.e. *inter*temporally optimal taxation.

$$m_{it} > 0 \quad \Leftrightarrow i_{it} < \theta_i \gamma_i \tag{11}$$

The present value of domestic social welfare is equal to:

$$U_{it} = \int_{t_0}^{\infty} \{y_{it} - \tau_{it} - h_i - i_{it} m_{it} + v(m_{it})\} e^{-\delta t} \, dt \tag{12}$$

National public finance is subject to the intertemporal budget constraint on public finance, which is found by integrating eq.(7) w.r.t. time:

$$\int_{t_0}^{\infty} \{g_{it} + \kappa_i(\tau_{it}) - \tau_{it}\} e^{-\delta t} dt = \int_{t_0}^{\infty} \{i_{it} m_{it}^s\} e^{-\delta t} dt \tag{13}$$

according to which the present value of all future primary fiscal deficits is equal to the present value of future seignorage revenues.

Social welfare maximizing monetary policies.

The social welfare maximization problem is solved by maximizing the indirect social welfare function, which is found by substituting eq.(13) and eq.(9) into eq.(12), with respect to the domestic nominal interest and ordinary taxes:

$$\max U_{it} \; _{i_{it}, \tau_{it}} \int_{t_0}^{\infty} \{y_{it} - g_{it} - \kappa_i(\tau_{it}) - h_i - \frac{\theta_i(\gamma_i - m_{it})^2}{2}\} e^{-\delta t} dt \tag{14}$$

It is also possible to carry out the welfare maximization program with the rate of domestic credit growth, μ_i, as the monetary policy instrument instead of the nominal interest rate because of the one-to-one relation between both variables in the absence of uncertainty. From the two f.o.c.'s of the indirect social welfare function in eq.(14), the following static optimality condition on efficient interest rate targeting and ordinary taxation results:

$$i_{it} = \theta_i \kappa_i'(\tau_{it}) \tag{15}$$

which indicates the need to set a proportionally higher interest rate in the presence of

higher marginal distortions such as to raise higher seignorage revenues. If we substitute eqs.(15), (10) and (8) into eq.(14) it is possible to determine social welfare of country i at time t with a national currency, U_{it}^{NC}, as a function of $\{h_i,\beta_i,\theta_i\}$ for a given dynamic path of y_{it} and g_{it}:

$$U_{it}^{NC} = \int_{t_0}^{\infty} \{y_{it} - g_{it} - \kappa_i(\tau_{it}) - h_i - \frac{\theta_i^2 \kappa_i'(\tau_{it})^2}{2}\} e^{-\delta t} dt$$

Apart from differences in h_i and θ_i, the EC countries are likely to differ in the efficiency of collecting ordinary taxes. When these differences are substantial, the countries cannot be considered to form an optimal currency area, a point convincingly stressed by Canzoneri & Rogers (1990).

Assume that the ECU interest rate at time t is equal to its theoretical basket value:

$$i_t^{ecu} = \bar{i}_t = \sum_i \lambda_i i_{it} = \sum_i \lambda_i \theta_i \kappa_i'(\tau_{it}) = \bar{\theta}\bar{\kappa}'(\bar{\tau}_t) \qquad (17)$$

in which λ_i is the share of EC country i in the value of the ECU. Variables with a bar are weighted EC averages, with weights λ_i. The weights were adjusted with the Treaty of Maastricht in which it was also decided that these weights will remain the same till the ECU has become a common currency. The current weights are:

DM	32.63	PES	4.50
FFR	19.89	DKR	2.56
PST	11.45	IPT	1.06
DFL	10.23	ESC	0.71
BFR	8.28	GDR	0.53
ITL	8.18		

Table 1 Current ECU weights[7].

[7] DM=Deutsch Mark, FFR=French Franc, PST=Pound Sterling, DFL=Dutch Guilder, BFR=Belgian Franc, ITL=Italian Lire, PES=Spanish Peseta, DKR=Dansih Krona, IPT=Irish Pound, ESC=Portugese

§ 3. Consequences of a common currency.

The final step in the process of European monetary integration of the past decades, as already indicated in the introduction, consists of a complete replacement of the current EC national monies by a common currency, the ECU. A European Central Bank will control the ECU supply as part of its monetary policies that replace the monetary policies of the current national Central Banks. Hasse (1990) (Chapter 5 and 6) provides an interesting reading on institutional background of this ECB. Much emphasis in the design of this ECB will have to be put on its objectives, instruments and its degree of independence from fiscal policymakers and politicians in general.

Replacing national currencies by a common currency clearly has some consequences even in our simple model. Three important implications that we will concentrate upon are the effect on real seignorage revenues of country i, the disappearance of transaction costs when a common currency is available and the effects of the imposition of EC - wide interest and inflation rates that are not efficient from a national perspective: the costs of a common currency when the EC is not an actual optimal currency area. Purpose of this section is to determine under which conditions country i will benefit from a common currency and under which circumstances it will not. In order to do so we compare social welfare with national currencies -as considered in the last section- with social welfare with a common currency in the EC. Social welfare with national currencies acts as a kind of 'base'-scenario of social welfare with which social welfare with a common currency is compared. We cannot expect country i to stick to its commitment of adopting the common currency if it has no social welfare improvement or even a loss in social welfare from doing so, as compared to a situation where small country i reneges on its commitment to replace its national currency by the common currency. The benefits from a common currency materialise in the model as a permanent saving h_i in real resources each period, from the disappearance of former transaction and information costs[8].

Escudo, GDR=Greek Drachma.

[8] A company transacting business in all EC member States, e.g., will have to buy and sell 12 different currencies to effect all its transactions. This results in administrative costs, costs from the exposure to exchange related risks, expenses in the form of commissions and fees, opportunity costs and complicating

On these static efficiency gains the European Commission (1990) notes:

"The addition of a single currency to a single market will perfect the resource allocation function of the price mechanism at the level of the Community as a whole. Overall transaction costs can be conservatively estimated to amount to 1/2% of GDP (ECU 13 to 19 billion per year) for the Community as a whole, which is to be compared to the 1/4% of GDP estimated in the Cecchini report for border costs for the circulation of goods."

Apart from these static efficiency gains, a common currency is likely to produce dynamic efficiency gains in the form of a higher growth rate of output. These dynamic efficiency gains, though very interesting, lie outside the scope of the current analysis, which assumes constant output for simplicity. It would be interesting to analyse the dynamic efficiency gains of a common currency in the framework of the New Growth Theory. A common currency in this framework could give rise to an endogenous growth process. A common currency in the EC will possibly also give rise to 'external' benefits -benefits in extra-EC trade and finance- besides 'internal benefits'. The European Commission notes in this respect:

"First, the ECU would become one of the major world currencies alongside the dollar and the yen, and could acquire a vehicular role in trade and finance for EC residents as well as nonresidents. This could bring additional savings on transaction costs, yield some revenues from international seignorage, and impact on macroeconomic stability. Second, the Community would be able to engage more effectively in international policy coordination and to speak with a single voice in international monetary affairs."

Seignorage revenues of the ECB, s_t^{ec}, are defined as:

$$s_t^{ec} = i_t^{ecu} m_t^{ec} = i_t^{ecu} \sum_i m_{it}^{ec} = i_t^{ecu} \sum_i (\gamma_i - \frac{1}{\theta_i} i_t^{ecu}) \qquad (18)$$

in which m_{it}^{ec} is the demand for real ECUs in country i which replaces the national

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pricing policies, cash and currency management.

currency. m_i^{ec} is the aggregated real ECU money demand; Sardelis (1993) refers to m_i^{ec} as the European Monetary Aggregate (EMA) and discusses how EMA targeting policies of the ECB can be implemented in the transition phase towards a common currency and after the introduction of the common currency. Crucial in the implementation of EMA targeting policies is the presence of a stable relationship between the EMA and the ultimate targets of inflation and output. Estimation of an EC aggregate money demand function has been undertaken, e.g. by Kremers and Lane (1990): substantial evidence is presented that the EMA displays -both in the short- and long run- a higher degree of stability and predictability than the national money demand functions and they consequently assert that the ECB in principle could implement more effective monetary control than could be achieved independently by the individual national central banks.

As a consequence of its objective of targeting the EMA, the ECB effectively starts to function as an EC wide redistributing device of seignorage revenues: each country is entitled to recieve its share, λ_i,[9] of ECB seignorage revenues. Only in the case where the γ_i and θ_i of countries are relatively equal, no seignorage redistribution would occur: ECU seignorage revenues from residents of country i are simply tansferred back to the monetary authorities of country i. The intertemporal government budget constraint with a common currency changes into:

$$\int_{t_0}^{\infty} \{g_{it} + \kappa_i(\tau'_{it}) - \tau'_{it}\} e^{-\delta t} dt = \int_{t_0}^{\infty} \{\lambda_i s_t^{ec}\} e^{-\delta t} dt \qquad (19)$$

Ordinary taxes have to be changed from τ_{it} to τ'_{it} permanently if real seignorage revenues of country i change as a consequence of a common currency. The change in net real seignorage revenues of country i, as a consequence of the replacement of its national currency by a common currency, is equal to:

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[9] The statutes of the European Central Bank determine that the shares in the ECB and therefore the shares of the seignorage revenues, λ_i, from a common currency issued by the ECB will be the average of GDP and population weights in the EC aggregate GDP and population. These weights differ from the current ECU weights and tend to support the countries with low GDP per capita and to "tax" the countries with high GDP per capita.

$$s'_{it} - s_{it} = \lambda_i s_t^{ec} - i_t m_{it} = -(\tau'_{it} - \tau_{it}) \tag{20}$$

in which $\lambda_i s_t^{ec}$ is the real seignorage share of country i in real seignorage revenues of the ECB. If the expression in eq.(20) is negative a rise in ordinary taxation from τ_{it} to τ'_{it} is necessary to compensate for the drop in real seignorage revenues of country i. The increase in ordinary taxation will be costly in countries with high inefficiencies in their tax system. The social costs from the raise in ordinary taxes because of the disappearance of seignorage revenues from a national currency, are equal to:

$$\kappa_i(\tau'_{it} - \tau_{it}) = \beta_i(\tau'_{it} - \tau_{it}) = -\kappa_i(s'_{it} - s_{it}) = -\beta_i(s'_{it} - s_{it}) \tag{21}$$

Social welfare of country i with a common currency managed by the ECB, U_{it}^{CC}, is equal to:

$$U_{it}^{CC} = \int_{t_0}^{\infty} \{y_{it} - \tau'_{it} - i_t^{ecu} m_{it}^{ec} + v(m_{it}^{ec})\} e^{-\delta t} dt \tag{22}$$

Note that the transaction - and information costs h_i have disappeared with a common currency. Using eqs.(9), (17)-(19) eq.(22) can be written as:

$$U_{it}^{CC} = \int_{t_0}^{\infty} \{y_{it} - g_{it} - \kappa_i(\tau'_{it}) - \lambda_i \sum_i \bar{\theta}\bar{\kappa}'(\bar{\tau}_t)(\gamma_i - \frac{\bar{\theta}\bar{\kappa}'(\bar{\tau}_t)}{\theta_i}) - \bar{\theta}\bar{\kappa}'(\bar{\tau}_t)\gamma_i + \frac{\bar{\theta}^2\bar{\kappa}'(\bar{\tau}_t)^2}{2\theta_i}\} e^{-\delta t} dt \tag{23}$$

Social welfare in the case of a common currency can be compared with social welfare without a common currency as analysed in the preceeding section. The replacement of national currencies has utility effects, public finance effects and resoure effects. In comparing social welfare with a common currency with social welfare with national currencies, these effects are taken into account in a consistent manner:

$$U_{it}^{CC} - U_{it}^{NC} = \int_{t_0}^{\infty} \{h_i - \kappa_i(\tau'_{it} - \tau_{it}) + \lambda_i s_t^{ec} - i_t^{ecu} m_{it}^{ecu} + v(m_{it}^{ecu} - m_{it})\} e^{-\delta t} dt \tag{24}$$

Three effects determine the change in social welfare in country i from a replacement of national currencies by a common currency: a static efficiency effect results from lower transaction costs with a common currency, public finance consequences result from a

change in seignorage revenues -this effect is captured by the second term in eq.(24)-, utility effects result from different real money balances with a national and a common currency -these utility effects are represented by the third and fourth term in eq.(24)-. With the aid of eqs.(21), (18), (17), (9) and (8), we can rewrite eq.(24) into:

$$U_{it}^{CC} - U_{it}^{NC} = \int_{t_0}^{\infty} \{h_i + (\beta_i + 1)\lambda_i \sum_i (\bar{\theta}\bar{\beta}(\gamma_i - \frac{\bar{\theta}\bar{\beta}}{\theta_i}) + \theta_i \beta_i^2 (\beta_i - \gamma_i + \frac{1}{2}) + \bar{\theta}\bar{\beta}(\frac{\bar{\theta}\bar{\beta}}{2\theta_i} - \gamma_i)\} e^{-\delta t} dt \tag{25}$$

According to eq.(25) the social welfare change of a replacement in country i of its national currency by a common currency, depends on $\{h_i, \lambda_i, \gamma_i, \theta_i, \bar{\theta}, \beta_i, \bar{\beta}\}$. In the next section we evaluate empirically the net social welfare change of eq.(25) of replacing a national currency by a common currency for the individual EC countries.

§ 4. Empirical investigation of social welfare consequences of a common currency.

The theoretical analysis resulted in an expression that measured the social welfare change from a removal of national currencies by a common currency. Purpose of this section is to evaluate this expression for the 11 EC countries to assess the individual effects. It is possible to obtain estimates of the structural parameters γ_i and θ_i in eq.(10) across the EC. In order to do so an error-correction form of a generalization of eq.(10),

$$m_{it} = \gamma_i - \eta_i^{lt} i_{it} + \epsilon_{it} \tag{26}$$

is estimated, in which m_{it} is the natural logarithm of real non-interest bearing money (M1), i_{it} the short term nominal interest rate in country i. η_i^{lt} is the long term semi-interest elasticity of real money demand and equal to $1/\theta_i$. Data were available from the OECD Main Economic Indicators and Quarterly National Accounts. A sample running from January 1984 till December 1992 was constructed: quarterly data were gathered for all EC countries.

Estimation of eq.(26) results in estimates of $\{\gamma_i, \theta_i\}$ of each country. The error-correction method proceeds in 2 steps: first the 'static' money demand function, eq.(26) is

estimated. Stationarity of the errors ε_{it} means by definition that cointegration between the non-stationary variables is present. In the second stage, a 'dynamic equation' for the first difference of the dependent variable is estimated. Included in the dynamic equation includes is the lagged disturbance error from the first stage estimation of the static equation, the s.c. 'error-correction' term:

$$\Delta m_{it} = -\eta_i^{st} \Delta i_{it} + \rho_i \epsilon_{i\,t-1} + u_{it} \qquad (27)$$

The error-corection term $\rho_i \varepsilon_{i\,t-1}$-if significant at least- measures by how much real money demand in each period is adjusted towards its steady state: a value of ρ_i of 0.4 e.g. implies that 40% of the adjustment is made within one period of observation. $-\eta_i^{st}$ is the short term semi-interest elasticity of real money demand. The estimation results of these dynamic and static equation of the 11 EC countries are summarized in table 2[10]:

[10] Belgium includes Luxemburg.

	γ_i	η_i^{LT}	θ_i	η_i^{ST}	ρ_i	$\bar{R}^2$	DW	$S.E.$	DF
BG	*7.19* *(65.04)* -	*-0.02* *(-1.82)* -	*46.91* -	- *-0.03* *(-3.07)*	- *-0.87* *(-6.93)*	*0.49* *0.40*	*2.65* *1.61*	*0.05* *0.05*	*-8.13* *[-2.95]* -
DK	*5.27* *(16.09)* -	*-0.02* *(-3.19)* -	*62.44* -	*-0.02* *(-2.05)* -	*-0.54* *(-1.96)* -	*0.92* *0.51*	*1.75* *1.90*	*0.02* *0.03*	*-4.01* *[-2.99]* -
FR	*7.28* *(99.64)* -	*-0.01* *(-1.75)* -	*75.51* -	- *0.02* *(1.89)*	- *-1.28* *(-10.31)*	*0.20* *0.57*	*2.26* *1.85*	*0.04* *0.03*	*-6.95* *[-2.95]* -
GE	*5.69* *(35.42)* -	*-0.01* *(-1.56)* -	*83.73* -	- *-0.02* *(-2.23)*	- *0.76* *(4.56)*	*0.98* *0.86*	*1.59* *2.48*	*0.03* *0.03*	*-7.17* *[-2.95]* -
GR	*6.22* *(56.57)* -	*-0.02* *(-3.37)* -	*-46.21* -	- *-0.01* *(0.95)*	- *-0.99* *(-4.52)*	*0.81* *0.85*	*1.92* *2.03*	*0.03* *0.04*	*-4.99* *[-2.97]* -
IT	*12.77* *(42.63)* -	*-0.01* *(-1.42)* -	*114.21* -	- *0.00* *(0.16)*	- *-0.21* *(-2.09)*	*0.47* *0.29*	*2.34* *2.02*	*0.07* *0.06*	*-2.96* *[-2.95]* -
NL	*4.46* *(86.97)* -	*-0.01* *(-1.98)* -	*91.61* -	- *-0.01* *(-2.32)*	- *0.20* *(1.31)*	*0.98* *0.85*	*1.90* *2.08*	*0.02* *0.02*	*-5.56* *[-2.95]* -
PT	*7.59* *(100.38)* -	*-0.03* *(-7.65)* -	*31.79* -	- *-0.02* *(-1.81)*	- *-0.42* *(-2.26)*	*0.91* *0.16*	*1.98* *1.95*	*0.06* *0.06*	*-6.01* *[-2.95]* -
ES	*9.02* *(30.95)* -	*-0.01* *(-1.61)* -	*148.58* -	- *-0.01* *(-2.88)*	- *-0.35* *(-2.17)*	*0.96* *0.51*	*1.39* *1.95*	*0.05* *0.04*	*-6.21* *[-2.95]* -
UK	*4.69* *(8.95)* -	*-0.02* *(-1.05)* -	*59.33* -	- *-0.01* *(-0.92)*	- *0.10* *(0.61)*	*0.93* *0.11*	*1.99* *1.96*	*0.12* *0.11*	*-6.71* *[-2.95]* -
IR	*1.26* *(6.88)* -	*-0.04* *(-2.07)* -	*28.64* -	- *0.00* *(0.26)*	- *-0.08* *(-1.46)*	*0.08* *-0.06*	*2.30* *1.17*	*0.06* *0.19*	*-2.79* *[-2.95]* -

Table 2 Estimation results of eqs.(26)-(27) t-statistics in parantheses. Critical values of the Dickey-Fuller test on stationarity of the residuals in brackets, level of significance 95%.

The test statistic DF forms a Dickey-Fuller test on stationarity of the error term in the static equation, eq.(26), a prerequisite for error-correction estimation to be meaningful. In all cases, except for Ireland the error term is found to be stationary. Since stationarity of the error term in the case of Ireland was only marginally rejected, the error-correction estimation was also undertaken in the case of Ireland. Eqs.(26) and (27) are a special case of a general money demand function which has real income and the nominal interest rate as its arguments:

$$m_{it} = \alpha_i^{lt} y_{it} - \eta_i^{lt*} i_{it} + \epsilon_{it}^{*} \tag{28}$$

in which y_{it} is the natural logaritm of real GDP of country i. α_i^{lt} is the long term semi-income elasticity of real money demand. η_i^{lt} and ε_{it} are in this case marked with a star to indicate that they in principal will differ as compared to eq.(26). Eqs.(26)-(27) represent a situation with constancy of output, an assumption that was maintained thoughout our theoretical part. The dynamic equation from eq.(28) is given by:

$$\Delta m_{it} = \alpha_i^{st} \Delta y_{it} - \eta_i^{st*} \Delta i_{it} + \rho_i^{*} \epsilon_{it-1}^{*} + u_{it}^{*} \tag{29}$$

Eqs.(28) and (29) were also estimated to check whether the constancy of output assumption induces a severe misspecification because of an omitted variable bias that could be induced. The estimation results on the static form, eq.(28), and the dynamic form, eq.(29), are found in table 3. No attempt was made to estimate the EMA demand function because it was preferred to adhere to its theoretical definition as introduced around eq.(18).

	α_i^{LT}	η_i^{LT}	α_i^{ST}	η_i^{ST}	ρ_i	R^2	DW	$S.E.$	DF
BG	*0.82* *(99.21)* -	*-0.01* *(-1.69)* -	- *0.96* *(2.44)*	- *-0.02* *(-3.07)*	- *-0.64* *(-3.45)*	*0.74* *0.40*	*1.80* *1.61*	*0.04* *0.05*	*-5.13* *[-2.95]* -
DK	*0.82* *(93.12)* -	*-0.02* *(-3.06)* -	- *0.69* *(4.37)*	- *-0.01* *(0.91)*	- *-0.42* *(-1.48)*	*0.89* *0.47*	*1.70* *1.94*	*0.03* *0.03*	*-3.99* *[-2.99]* -
FR	*0.85* *(141.75)* -	*-0.01* *(-1.71)* -	- *1.17* *(1.56)*	- *0.01* *(2.14)*	- *-0.75* *(-5.79)*	*0.46* *0.69*	*1.80* *1.60*	*0.04* *0.03*	*-5.43* *[-2.95]* -
GE	*0.79* *(32.98)* -	*-0.00* *(-0.21)* -	- *0.76* *(1.26)*	- *-0.00* *(-0.26)*	- *-0.09* *(-0.41)*	*0.98* *0.70*	*1.95* *1.84*	*0.03* *0.04*	*-6.46* *[-2.95]* -
GR	*0.75* *(50.59)* -	*0.01* *(1.50)* -	- *0.40* *(1.21)*	- *0.01* *(0.84)*	- *-0.28* *(-1.24)*	*0.82* *0.81*	*1.96* *1.71*	*0.03* *0.04*	*-5.09* *[-2.97]* -
IT	*0.92* *(345.98)* -	*-0.00* *(-0.45)* -	- *-0.16* *(-0.37)*	- *-0.00* *(-1.44)*	- *-1.95* *(-23.84)*	*0.30* *0.86*	*2.01* *1.90*	*0.06* *0.03*	*-6.62* *[-2.95]* -
NL	*0.74* *(102.52)* -	*-0.02* *(-2.95)* -	- *0.38* *(2.01)*	- *-0.01* *(-2.82)*	- *0.13* *(0.77)*	*0.99* *0.87*	*1.97* *2.03*	*0.02* *0.02*	*-5.82* *[-2.95]* -
PT	*0.86* *(143.37)* -	*-0.01* *(-3.73)* -	- *1.08* *(2.40)*	- *-0.01* *(-1.11)*	- *-0.57* *(-3.11)*	*0.93* *0.30*	*2.07* *1.94*	*0.05* *0.05*	*-5.70* *[-2.95]* -
ES	*0.87* *(61.49)* -	*-0.01* *(-2.38)* -	- *1.88* *(6.08)*	- *-0.01* *(-2.77)*	- *-0.07* *(-0.53)*	*0.98* *0.69*	*1.51* *1.91*	*0.04* *0.03*	*-5.53* *[-2.95]* -
UK	*0.80* *(10.60)* -	*-0.02* *(-1.16)* -	- *1.98* *(1.26)*	- *-0.02* *(-1.29)*	- *-0.06* *(-0.34)*	*0.94* *0.13*	*2.09* *1.99*	*0.12* *0.11*	*-6.94* *[-2.95]* -
IR	*0.45* *(9.87)* -	*-0.04* *(-3.19)* -	- *0.29* *(0.48)*	- *0.00* *(0.15)*	- *-0.13* *(-1.96)*	*-0.03* *0.44*	*2.23* *2.31*	*0.06* *0.15*	*-2.55* *[-2.95]* -

Table 3 Estimation results of eqs.(28)-(29), t-statistics in parantheses. Critical values of the Dickey-Fuller test on stationarity of the residuals in brackets. Level of significance 95%

The estimated semi-elasticities have the expected sign in most cases and are more or less consistent with other empirical studies (Fase & Winder (1993)). Comparison of the parameter estimates of eq.(26) and eq.(28) shows that the estimates of η_i are not severly affected when estimating eq.(26) instead of eq.(28). With the aid of these estimates of θ_i and γ_i it is possible to evaluate eq.(25) and to determine when a country is likely to benefit from a common currency and when not. 'One Market, One Money' reviews in its Chapter 10 the potential costs and benefits for the EC-countries qualitatively, but does not give any quantitative estimates of the saving in transaction costs for each EC country seperately. The estimate of 0.5% of GDP of h_i is taken as a starting value in the remainder of the analysis. Assume that average national interest rates will satisfy eq.(15): if we know θ_i and fill in the average interest rate we can calculate the initial marginal distortion from ordinary taxation, $\kappa_i'(\tau_{ii})$, which is this case equal to β_i. In eq.(21) we had already determined the necessary change in ordinary taxes, $(\tau'_{ii} - \tau_{ii})$.

Table 4 calculates the social welfare changes when national monies are replaced by a common currency in country i, according to eq.(25). Rows 1-3 give the parameter values that have been estimated/given. The natural logarithm of real GDP at the end of 1992 is given in row 4. The marginal distorsion of ordinary taxation is calculated in row 7 using eq.(15) and average nominal interest rates over the sample period. The instantaneous change in social welfare is given in row 8 by U_i^{CC}-U_i^{NC}, in row 9 it is expressed as a fraction of real GDP. The integral in eq.(25) can be approximated by dividing the instantaneous social welfare change by the rate of time preference (set at 0.05 e.g.), if it is assumed that the parameters would remain approximately constant after the monetary reform since then the expression that is integrated forms a geometric sum.

h_i^{crit} in row 10 is that value of h_i that would make country i indifferent between having its national currency or a common currency. If this critical h_i^{crit} is higher it becomes less likely that country i will move to a common currency. These critical h_i^{crit} could also indicate a kind of bargaining position. A country with a high h_i^{crit} is likely to be in a stronger bargaining position with regard to the division of shares in the ECB than a country with a low h_i^{crit}: countries with a h_i^{crit} less than 0.5% would benefit if the benefits of a common currency would be less than 0.5% but larger than h_i^{crit}, while countries with a h_i^{crit} larger than 0.5% still would loose if the benefits would be higher than 0.5% but lower than h_i^{crit}.

	BG	DK	FR	GE	GR	IT	NL	PT	SP	UK	IR
λ_i	8.28%	2.56%	19.89%	32.63%	0.53%	8.18%	10.23%	0.71%	4.50%	11.45%	1.06%
θ_i	46.91	62.44	75.51	83.73	46.21	114.21	91.61	31.79	148.58	59.33	28.64
γ_i	7.19	5.27	7.28	5.69	6.22	12.77	4.46	7.59	9.02	4.69	1.26
y_{it}	8.69	6.54	8.56	6.35	8.36	13.83	4.78	8.62	10.55	6.01	3.04
units	BLN BFR	BLN DKR	BLN FFR	BLN DM	BLN GRD	BLN ITL	BLN GLD	BLN ESC	BLN PES	BLN PST	BLN IRP
β_i	0.002	0.002	0.001	0.001	0.004	0.001	0.001	0.005	0.001	0.002	0.004
$U_i^{CC} - U_i^{NC}$	-0.041	-0.083	0.080	0.266	-0.160	-0.202	0.039	-0.194	-0.159	0.028	-0.013
% y_{it}	-0.47%	-1.26%	0.94%	4.19%	-1.92%	-1.46%	0.81%	-2.25%	-1.51%	0.47%	-0.43%
h_i^{crit}	0.97%	1.76%	-0.44%	-3.69%	2.42%	1.96%	-0.31%	2.75%	2.01%	0.03%	0.93%

Table 4 Social welfare consequences of a common currency.

The table indicates that for the model parameter values estimated/chosen, the expression in brackets in eq.(25) has a positive value for France, Germany, the Netherlands and the UK while a negative outcome results for the other countries. It is not surprising that the net effect is positive in the case of France, Germany, the Netherlands and the UK because of their relative high share in ECB seignorage. The seignorage redistribution effects from a removal of national currency -and to a lesser extent the resource effects- dominate the net social welfare effect of eq.(24): the utility effects are relatively small. These outcomes raise doubt whether the smaller southern EC countries will stick to their commitment to replace their national currency by the ECU, as it could possibly lead to a reduction in their social welfare.

Clearly the potential benefits from a common currency, h_i, in our model will be very uncertain in reality and it is not pretended that fixing them at 0.5% of GDP is an accurate procedure. It is therefore interesting to look at the social welfare changes with different values of h_i. Figure 1 determines the social welfare change from a common currency for different values of h_i in the case of Italy, a country that will suffer from introducing a common according to our predictions, and in the case of Germany that will benefit from a common currency.

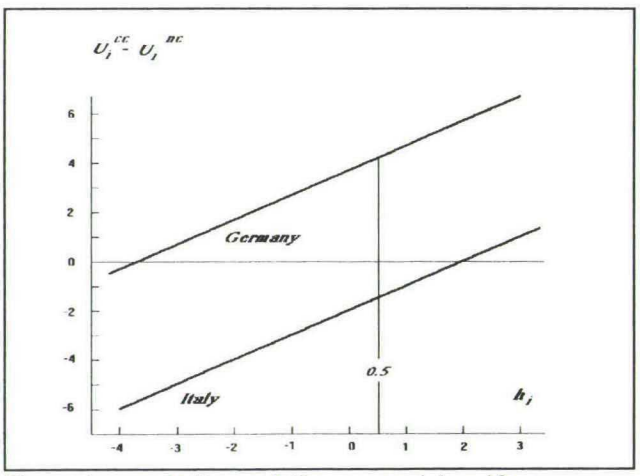

Figure 1. Italian and German social welfare effects as a function of h_i.

The figure illustrates the relative importance of the benefits from a common currency on social welfare. The comparison between Italy and Germany indicates the substantial intra-EC differences that are possible in the relative effects of a removal of national currencies by a common currency, mainly caused by the substantial seignorage redistribution that this monetary reform entails.

In table 5 the calculations of table 4 are repeated except that different weights, λ_i', have been used: namely based on the proposed rule on the division of ECB shares of 0.5 times of GDP if country i plus 0.5 times the population of country i. These weights differ to a certain degree from the current ECU weights and therefore the social welfare consequences of a common currency are also different: countries with a higher weight in table 4 than in table 5 experience, not surprisingly, some decrease in their gain or loss from a common currency when comparing both tables, while countries with a smaller share in table 4 than in table 5 improve their results when moving from table 4 to 5. In all cases -except for the Netherlands which now experience a small social welfare loss from a common currency- the sign of the net effect is the same but the exact magnitudes of the effects by using these weights instead those of table 4 differ to some extent.

	BG	DK	FR	GE	GR	IT	NL	PT	SP	UK	IR
λ_i'	3.15%	1.79%	17.84%	24.18%	2.05%	17.39%	4.51%	1.97%	9.86%	16.41%	0.86%
θ_i	46.91	62.44	75.51	83.73	46.21	114.21	91.61	31.79	148.58	59.33	28.64
γ_i	7.19	5.27	7.28	5.69	6.22	12.77	4.46	7.59	9.02	4.69	1.26
y_{it}	8.69	6.54	8.56	6.35	8.36	13.83	4.78	8.62	10.55	6.01	3.04
units	BLN BFR	BLN DKR	BLN FFR	BLN DM	BLN GRD	BLN ITL	BLN GLD	BLN ESC	BLN PES	BLN PST	BLN IRP
β_i	0.002	0.002	0.001	0.001	0.004	0.001	0.001	0.005	0.001	0.002	0.004
$U_i^{CC} - U_i^{NC}$	-0.107	-0.099	0.059	0.182	-0.153	-0.110	-0.028	-0.192	-0.109	0.087	-0.017
% y_{it}	-1.24%	-1.52%	0.69%	2.87%	-1.83%	-0.79%	-0.59%	-2.22%	-1.03%	1.44%	-0.55%
h_i^{crit}	1.74%	2.02%	-0.19%	-2.37%	2.33%	1.29%	1.09%	2.72%	1.53%	-0.94%	1.05%

Table 5 Social welfare consequences of a common currency with different weights.

§5. Conclusions

In this paper an attempt was made to evaluate the possible social welfare consequences of the replacement of national currencies by a common currency, the ECU, managed by a European Central Bank. A small EC-economy model was set up in which the consequences, in the form of static efficiency gains, seignorage redistribution and pure utility effects, of the final replacement by a common currency were analysed.

An import consequence of a common currency, is the partial loss of fiscal policy autonomy: with a common currency participating countries adopt a common rate of inflation which is likely to be non-efficient when looking at the individual marginal distorsions from ordinary taxation. The induced changes in seignorage revenues have to be compensated by opposite and equal changes in ordinary taxes which may be costly in countries with a relatively high marginal distorsion from ordinary taxes.

The calculated social welfare changes from a removal of national currencies by a common currency according to the model were evaluated empirically for the different EC-countries. The empirical evaluation of the social welfare change from replacing a national currency by a common currency, indicated that under present conditions a removal of national currencies by a common currency possibly causes non-negligible social welfare changes across the EC. The calculations indicated that the induced static efficiency effects and the public finance effects of a common currency dominated the pure utility efects. Doubt was raised with regard to the question whether all countries will actually stick to their commitment of a common currency.

The calculations furthermore indicated that the social welfare change from replacing national currencies by a common currency depends strongly on the initial situation in which such a monetary reform is implemented and on the amount of benefits of a common currency. On these benefits a high degree of uncertainty remains and further theoretical and empirical research is highly needed. Besides of the 'static' efficiency gains, 'dynamic efficiency gains' from a common currency are likely to arise. Attention was paid to the effects of different shares in the European Central Bank seignorage.

References

Allen, P. (1990), The Private ECU Markets. What they are, why they exists and where they may go, Journal of Banking and Finance 14, 845-876.

Canzoneri, M. & Rogers, C. (1990), Is the European Community an Optimal Currency Area? Optimal Taxation versus the Cost of Multiple Currencies, American Economic Review 80, 419-433.

European Commission (1990), One Market, One Money. An Evaluation of the Potential Benefits and Costs of Forming an Economic and Monetary Union, European Economy, no.44 1990.

Fase, M. & Winder, C. (1993), The Demand for Money in the Netherlands and the other EC Countries, De Economist 141, 471-496.

Hasse, R. (1990), The European Central Bank: Perspectives for a Further Development of the European Monetary System, Bertelsmann Foundation Publishers.

Kremers, J. and Lane, T. (1990), Economic and Monetary Integration and the Aggregate Demand for Money in the EMS, IMF Staff Papers 4, 777-805.

Lemmen, J. and Eijffinger, S. (1994), The Price Approach to Financial Integration: Decomposing European Money Market Interest Rate Differentials, Center Discussion Paper no. 16 1994.

Poole, W. (1970), Optimal Choice of Monetary Policy Instruments in a Simple Stochastic Macro Model, Quarterly Journal of Economics, 85, 197-216.

Sardelis, C. (1993), Targeting a European Monetary Aggregate. Review and Current Issue, Economic Papers no. 102, 1-54, Commission of the European Communities.

Vègh, C. (1989), Government Spending and Inflationary Finance, IMF Staff Papers 3, 657-677.

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